Claims

1. Procedure for the determination of the quality of gas of a probe gas (1), in particular a burnable gas, proceeding from a transmission spectrum of the probe gas (1) determined at operating conditions by means of spectroscopical methods of measurement,

   characterized in that

   - out of the spectrum the amounts of substances x_i of the components of the probe gas (1) are determined at operating conditions,
   - default values for compressibility factor K and real gas factor Z_n are preset for calculation of the wanted compressibility factor K,
   - out of quantities at operating conditions of the probe gas (1) as well as from the amounts of substances x_i and substance specific quantities and taking into account of the selected default values for compressibility factor K and real gas factor Z_n input quantities for the determination of the compressibility factor K are determined,
   - with these input quantities the compressibility factor K is calculated by means of standard-arithmetic procedures,
   - an iterative calculation in the way of an iterative recalculation of the input quantities is carried out with the determined value for the compressibility factor K as long, until the value of the compressibility factor K converges and than there from the volumetric standard calorific value $H_{v,n}$ and the standard density ρ_n is calculated.

2. Procedure according to claim 1, **characterized in that** as standard-arithmetic procedure the method of iteration AGA8-92DC is used.

3. Procedure according to claim 1, **characterized in that** as standard-arithmetic procedure the method of iteration GERG88 is used.

4. Procedure according to one of the preceding claims, **characterized in that** the amounts of substances x_i of the infrared active components of the probe gas (1) at operating conditions is determined starting from the recorded spectrum by means of multivariate analysis (MVA).

5. Procedure according to one of the preceding claims, **characterized in that** the default values of the compressibility factor K und the real gas factor Z_n are taken from a characteristic diagram, that describes the influence of the pressure

p_b at operating conditions and the temperature T_b at operating conditions for a known composition of a gas similar to the composition of the probe gas (1).

6. Procedure according to one of the preceding claims, **characterized in that** directly from the spectrum the amounts of substances of the infrared active components of the probe gas (1) at operating conditions and the amount of nitrogen N_2 of the probe gas (1) are determined as a function of the amounts of substances of the infrared active components of the probe gas (1).
7. Procedure according to claim 6, **characterized in that** the amount of substance of nitrogen N_2 and the amounts of substances of the infrared active components complements each other resulting in the total volume of the probe gas (1).
8. Procedure for the determination of the quality of gas of a probe gas (1), in particular a burnable gas, proceeding from a transmission spectrum of the probe gas (1) determined at operating conditions by means of spectroscopical methods of measurement,

characterized in that

- default values for compressibility factor K and real gas factor Z_n are preset for calculation of the wanted compressibility factor K,
- from the pressure p_b at operating conditions and the temperature T_b at operating conditions of the probe gas (1) with the values for the calorific value $H_{v,b}$ at operating conditions and the density ρ_b at operating conditions, which can be directly determined out of the spectrum, input quantities for the determination of the compressibility factor K are determined,
- as further input quantity the molar amount of substance of CO_2 is determined by means of a further absorption band of the spectrum,
- with these input quantities the compressibility factor K is calculated by means of the iterational procedure GERG88,
- an iterative calculation in the way of an iterative recalculation of the input quantities is carried out with the determined value for the compressibility factor K as long, until the value of the compressibility factor K converges and than there from the volumetric standard calorific value $H_{v,n}$ and the standard density ρ_n is calculated.

9. Procedure according to claim 8, **characterized in that** the calorific value $H_{v,b}$ at operating conditions and the density ρ_b at operating conditions are determined by

means of spectral functions for weighting of a value directly from the spectrum of the probe gas (1).

10. Procedure according to claim 9, **characterized in that** with the spectral functions for weighting of a value the weighted influence of the amounts of substances of the components of the probe gas (1) is described for the calorific value $H_{v,b}$ at operating conditions and the density ρ_b at operating conditions.

11. Procedure according to one of the claims 8 to 10, **characterized in that** the default values for compressibility factor K and real gas factor Z_n are taken from a characteristic diagram, that describes the influence of the pressure p_b at operating conditions and the temperature T_b at operating conditions for a known composition of a gas similar to the composition of the probe gas (1).

12. Photometric device for the determination of a transmission spectrum of a probe gas (1), especially for carrying out one of the procedures according to claim 1 or claim 8, showing a radiation source (2) emitting a measurement radiation (8), in which the measurement radiation (8) passes through a probe cell (3) for capturing a probe gas (1) and enters after passing through a modulation unit (6) for modulating the measurement radiation (8) into at least one radiation receiver (7), which generates electrical measurement signals (9) according to the incoming intensity of the measurement radiation (8) and transmits these to an electronical unit (10), which determines a transmission spectrum out of the measurement signals (9), wherein the modulation unit (6) shows a spectral switch unit (45),

characterized in that

the radiation source (2) emitting a measurement radiation (8) is connected with the probe cell (3) and the probe cell (3) with the spectral switch unit (45) by means of at least each one light guiding device (19).

13. Photometric device according to claim 12, **characterized in that** between on the one hand the radiation source (2) emitting a measurement radiation (8) and the spectral switch unit (45) as well as the probe cell (3) a three-dimensional separation is provided, which can be bridged by means of the light guiding device (19).

14. Photometric device according to claim 13, **characterized in that** in the area of the three-dimensional separation between on the one hand the radiation source (2) emitting a measurement radiation (8) and the spectral switch unit

(45) as well as the probe cell (3) an explosion-proofed barrier (20) is provided.

15. Photometric device according to one of the claims 12 to 14, **characterized in that** the spectral switch unit (45) shows optical filters (21), with which regions of the transmission spectrum are extracted by filtering and are guided to the one or the respective radiation receivers (7).

16. Photometric device according to claim 15, **characterized in that** for each region of the spectrum to be filtered a special optical filter (21) and a respective radiation receiver (7) is provided.

17. Photometric device according to claim 15, **characterized in that** for each region of the spectrum to be filtered a special optical filter (21) is provided, which is arranged in a filter carrier (45), which is relatively movable relative to the radiation receiver (7).

18. Photometric device according to one of the claims 15 to 17, **characterized in that** the optical filters (21) and their filter regions are chosen in such a way, that they record directly spectral regions for evaluation with a procedure of the direct spectral evaluation (DSA).

19. Photometric device according to claim 18, **characterized in that** the spectral switch unit (45) is provided with each a filter (21) at least for CH_4, higher CH-compounds, CO_2 and a reference gas (24).

20. Photometric device according to one of the claims 12 to 19, **characterized in that** for the adjustment of the optical system of the device a spectroscopical inactive inert gas (23), preferably nitrogen N_2. is passable into the probe cell (3).

21. Photometric device according to one of the claims 12 to 20, **characterized in that** for examination of the measured values of the device a defined calibration gas (24) is passable into the probe cell (3).

22. Photometric device according to one of the claims 20 or 21, **characterized in that** the measurements for adjustment of the optical system and/or calibration of the measured values can be carried out in definable time intervals.

23. Photometric device for the determination of a transmission spectrum of a probe gas (1), especially for carrying out one of the procedures according to claim 1 or claim 8, showing a radiation source (2) emitting a measurement

radiation (8), in which the measurement radiation (8) passes through a probe cell (3) for capturing a probe gas (1) and enters after passing through a modulation unit (6) for modulating the measurement radiation (8) into at least one radiation receiver (7), which generates electrical measurement signals (9) according to the incoming intensity of the measurement radiation (8) and transmits these to an electronical unit (10), which determines a transmission spectrum out of the measurement signals (9), wherein the modulation unit (6) shows a spectral switch unit (46, 47),

characterized in that

the spectral switch unit (46, 47) shows a chopper arrangement (28), which transmits because of their selective transmission behaviour only specific spectral regions of the spectrum in the measurement radiation (8) caused by the probe gas (1) to the radiation receiver (7).

24. Photometric device according to claim 23, **characterized in that** the chopper arrangement (28) provides such a transmission behaviour, that the transmitted spectral regions are suitable for the further evaluation by procedures of the direct spectral evaluation (DSA).

25. Photometric device according to claim 24, **characterized in that** the chopper arrangement (28) is provided with a rotating aperture (46) with free sector elements (30, 31), which release regions of the measurement radiation (8) in respect of the radiation receiver (7), which correspond to appointable spectral regions of the measurement radiation (8).

26. Photometric device according to claim 25, **characterized in that** the chopper arrangement (28) is provided with an aperture (46) with free sectors (30), in which the release of the regions of the wavelength of the measurement radiation (8) is caused sequentially for separate spectral regions.

27. Photometric device according to claim 25, **characterized in that** the chopper arrangement (28) is provided with an aperture (46) with a spiral opening (31), in which the release of the regions of the wavelength of the measurement radiation (8) is caused continuously for the whole spectrum.

28. Photometric device according to one of the claims 23 to 27, **characterized in that** the released wavelength of the measurement radiation (8), which passes through the chopper arrangement (28), can be obtained by means of capturing the rotational position of the aperture (46).

29. Photometric device according to one of the claims 23 to 28, **characterized in that** the chopper arrangement (28) is provided with two groups of sector elements (36, 37) alternatively releasing the measurement radiation (8), in which a first optical waveguide (34) guides the measurement radiation (8) released by the sector elements of the first sector element group (36) into the probe cell (3) and after passing through the probe cell (3) to the radiation receiver (7) and a second optical waveguide (35) guides the measurement radiation (8) released by the sector elements of the second sector element group (37) directly to the radiation receiver (7).

30. Photometric device according to claim 29, **characterized in that** the measurement radiation (8) released by the sector elements of the sector element groups (36, 37) are concentrated by means of first optical waveguide (34) and second optical waveguide (35) into one or more filters (21) or a dispersive element (6), preferably a monochromator (32).

31. Photometric device according to claim 30, **characterized in that** the radiation receiver (7) collects the measurement radiation (8), which is coming out of the one or more filters or the dispersive element and each released through the sector elements of the sector element groups (36, 37) of both optical waveguides (34, 35).

32. Photometric device according to one of the claims 29 to 31, **characterized in that** the measurement radiation (8), which is released through the sector elements of the sector element groups (36, 37) of that optical waveguide (34), which is guided directly to the radiation receiver (7), is usable as reference for eliminating the influence of CO_2, which exists in the surrounding of the probe cell (3) and/or of the device, of changes of the radiation source (2) and/or of the radiation receiver (7).

33. Photometric device according to one of the claims 29 to 32, **characterized in that** the measurement radiation (8), which is each released through the sector elements (30, 31), is guided through the first and the second waveguide (34, 35) to the input of the one or more filters (21) or the dispersive element (6), in which at the chopper arrangement (28) also available further sector element groups (36, 37) lock on the measurement radiation (8), which is released of the one or more filters (21) or the dispersive element (6), alternatively to the radiation receiver (7).

34. Photometric device according to claim 30 or 33, **characterized in that** the measurement radiation (8), which is each released through the sector elements (30, 31), is guided together by means of the first and the second waveguide (34, 35) in a Y-fibre coupler (38), which guides the measurement radiation (8) of the first and the second waveguide (34, 35) to the one or more filters (21) or the dispersive element (6).

35. Photometric device according to one of the claims 33 to 34, **characterized in that** the chopper arrangement (28) carries out both the selection of the wavelengths for the spectrum as well as the alternating reverse of the measured section between the waveguides (34, 35).

36. Photometric device according to one of the claims 29 to 35, **characterized in that** the probe cell (3) is sweepable with an infrared inactive gas, preferably nitrogen N_2, for carrying out a null measurement for the compensation of dirt accumulation or the same of the optical facilities (2, 7, 32) of the device.

37. Photometric device according to one of the preceding claims, **characterized in that** the probe cell (3) contains an optical hollow shaft guide (39), into which the probe gas (4) can be lead.

38. Photometric device according to one of the claims 36 or 37, **characterized in that** the cross-sectional dimensions of the hollow shaft guide (39) are in general the same or less larger as the cross-sectional dimensions of the optical waveguide (34).

39. Photometric device according to one of the claims 36 to 38, **characterized in that** the hollow shaft guide (39) is directly connectable with the optical waveguide (34).

40. Photometric device according to one of the preceding claims, **characterized in that** for the coupling in of the measurement radiation (8) into a probe cell (3) the probe cell (3) is providable with lenses with a radial gradient of refraction index (43), so-called GRIND-lenses.

41. Photometric device according to one of the claims 12 to 40, **characterized in that** the measurement radiation (8) can be modulated according to amplitude and/or wavelength.

42. ~~Photometric device according to claim 41, **characterized in that** the radiation source (2) itself shows devices for modulating the measurement radiation (8).~~

43. ~~Photometric device according to claim 41, **characterized in that** the measurement radiation (8) passes through an additional modulation unit after leaving the radiation source (2), which modulates the measurement radiation (8).~~

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